PHYTOTOXICOLOGY ASSESSMENT SURVEY INVESTIGATION IN THE VICINITY OF LIBBEY-ST.CLAIR, WALLACEBURG, 1989

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Introduction

The Phytotoxicology Section has conducted annual vegetation assessment surveys in the vicinity of the Forhan Street South industrial park in Wallaceburg since 1976, with the exception of 1988. In the course of each annual surveillance, vegetation in the area has been examined for evidence of air pollutant injury and sampled for fluoride, boron and various heavy metals emitted by several different industrial sources.

Problems associated with excessive fluoride and chromium levels in tree foliage have been solved through effective abatement measures taken by the industries involved. Boron concentrations in tree foliage, however, have remained high in recent years at sites near the Libbey-St.Clair Glassworks on Forhan St. South. Boron is emitted from the Glassworks during the manufacture of borosilicate glass.

Each year, near the middle of August, maple tree (Manitoba, silver or Norway) foliage has been examined for boron-induced injury and then samples of the tree foliage collected for boron analysis. From 1976 to 1984, no injury associated with boron accumulation was observed on sensitive vegetation such as Norway maple. In 1985, boron injury was first observed on a Norway maple immediately south of the Glassworks. In 1986, typical boron-type injury symptoms were observed at the initial site as well as at a location immediately north of the Glassworks.

In 1987, boron-type injury was observed at 2 sites near the Libbey-St.Clair plant. The injury appeared typically as intercostal and/or marginal necrosis on up to 10% of the leaf area on the affected foliage. Boron injury was noted for the first time on silver maple foliage at one of the locations.

1989 Phytotoxicology Surveillance

On 23 August 1989 Mr. G. Vasiloff of the Phytotoxicology Section conducted the annual surveillance program at 12 sites (Figure 1) in the vicinity of the Glassworks, although several changes were made. Because the Norway maple at site 1 was unavailable in 1989, a Manitoba maple at a new location south of the company gate was selected as a replacement. At site 25, a silver maple tree was added to the existing Manitoba maple specimen.

At each site location, foliage of survey trees was examined for evidence of visible boron-induced injury. Observational notes relating to injury observations appear in Table 1. Confirmed boron injury was only observed at site 10. Although trace levels of injury were observed on the Manitoba and silver maples at the site, injury was considerably more severe on the more sensitive Norway maple foliage. Up to 80% terminal, marginal and intercostal necrosis was present on 60% of the foliage. In addition, 2-10% light brown terminal and marginal necrosis was observed on the youngest leaves. Light injury was also observed on maple foliage at sites 5, 7, 15 and 25 but boron could not be confirmed as the injury-causing agent.

Foliar samples at each survey site were collected in duplicate and stored in clean, new plastic bags. Samples were delivered to the Phytotoxicology vegetation processing laboratory, oven dried, ground and then submitted to the Ministry's Inorganic Trace Contaminants Section for boron analysis.

Chemical Analysis Results

Boron concentrations found in sampled maple foliage in the vicinity of the Libbey-St.Clair Glassworks have been assembled in Table 2. Values shown in the table represent the mean analytical results of the duplicate samples collected. The survey was not conducted in 1988 and therefore no analytical results are available.

For purposes of annual comparison, mean values for all foliar analytical results from sampling sites 5, 10 and 15 are shown at the bottom of the table. Also shown is the Phytotoxicology Upper Limit of Normal (ULN) guideline for boron in not-washed urban tree foliage. An explanation of the derivation of the ULN's is attached as Appendix I.

The table shows that the 1989 three-site mean (5, 10 & 15) of 159 ppm was the lowest since 1982. In spite of this, concentrations in excess of the ULN guideline were found in foliage at 5 sites. In 1987, exceedances were recorded at 6 sites, at 5 sites in 1986 but only at 3 locations in 1985.

Boron values found in Manitoba or silver maple foliage at sites along each of 3 radii (south, east and north) have been plotted in Figure 2. The graphs show that boron values generally were highest near the Glassworks and declined with increasing distance from the source.

Conclusions

Mean boron values found in the 1989 maple foliage at 3 sites close to the Glassworks were the lowest since 1982. Even so, boron values in excess of the Phytotoxicology ULN guideline were found in maple foliage at 5 of the 12 survey sites. This compares with 6 in 1987, 5 in 1986 and 3 in 1985.

Boron values in maple foliage along north, south and east radii demonstrated that concentrations of the element declined with increasing distance from the Libbey-St.Clair plant.

It is apparent from the mean values in foliage at sites close to the plant that emissions from the Libbey-St.Clair plant, have been relatively constant over the past 7 years. As described in the 1987 report, the variability in visible boron-type foliar injury could be due to high extractable boron values found in the soils. For this reason, injury due to airborne or soilborne boron sources is difficult to identify and separate.

TABLE: 1 **Observations of Visible Injury to Vegetation at Phytotoxicology Surveillance Sites in the Vicinity of Libbey-St. Clair, Wallaceburg - August 23, 1989**

Survey Site Number	Vegetation Species Examined	Visual Observations
1	Manitoba maple	No visible boron-type foliar injury.
2	Manitoba maple	No visible boron-type foliar injury. Some chlorotic mottle and herbicide-like injury observed.
	Silver maple	No visible boron-type foliar injury. Leaf scorch observed on youngest leaves.
3	Manitoba maple	No visible boron-type foliar injury.
	Silver maple	No visible boron-type foliar injury.
4	Manitoba maple	No visible boron-type foliar injury. Herbicide-like injury observed.
	Silver maple	No visible boron-type foliar injury.
5	Silver maple	Unidentified injury consisting of >0-1% terminal and marginal necrosis on scattered older leaves and chlorotic mottle on younger foliage. Herbicide-like injury observed.
6	Manitoba maple	No visible boron-type foliar injury. Traces of terminal and marginal chlorotic mottle.
	Silver maple	No visible boron-type foliar injury.
7	Manitoba maple	No visible boron-type foliar injury.
	Silver maple	Unidentified injury consisting of trace terminal necrosis on 70% of foliage.

TABLE: 1 (Cont'd)

Survey Site	Vegetation Species	Visual Observations
10	Manitoba maple	Visible boron-type injury consisting of >0-1% terminal necrosis on 30% of foliage.
	Silver maple	Visible boron-type injury consisting of trace terminal & marginal necrosis on 10% of foliage along with some intercostal chlorotic mottle.
	Norway maple	Visible boron-type injury consisting of: 1) up to 80% terminal, marginal and intercostal necrosis on 60% of foliage. 2) 2-10% terminal and marginal light brown necrosis on youngest foliage.
11	Manitoba maple	No visible boron-type foliar injury.
	Silver maple	No visible boron-type foliar injury.
15	Manitoba maple	Unidentified injury consisting of >0-1% terminal, marginal and intercostal necrotic spotting on 5% of foliage.
16	Silver maple	No visible boron-type foliar injury.
25	Manitoba maple	No visible boron-type foliar injury.
	Silver maple	Unidentified injury consisting of >0-1% terminal & marginal necrosis and chlorotic mottle.

TABLE: 2 Boron Values Found in Maple Foliage Collected Near Libbey-St.Clair Glassworks, Wallaceburg - 1989

Sampling Location	Maple Species	Distance & Direction from Glassworks	Boron Values (1982-1989) (ppm - dry weight) 1982	1983	1984	1985	1986	1987	1989
1	Mm	240 m S	—	—	—	—	—	—	56
	Nm		170	203	720	435	296	185	NA[1]
2	Sm	475 m S	175	103	96	92	121	100	78
	Mm		135	140	120	145	181	165	185
3	Sm	780 m S	160	147	155	140	164	NA	110
	Mm		—	—	—	—	—	45	245
4	Sm	960 m S	105	117	195	90	54	105	49
	Mm		140	127	210	125	135	200	78
5	Sm	180 m E	175	183	180	145	183	195	145
6	Sm	470 m E	65	71	66	41	66	85	83
	Mm		140	90	97	105	68	135	89
7	Sm	700 m E	80	111	195	125	76	115	59
	Mm		90	113	110	75	107	125	125
10	Sm	300 m N	130	130	135	115	144	140	115
	Mm		450	137	320	215	229	255	190
	Nm		125	193	145	150	219	155	195
11	Sm	560 m N	50	65	64	67	72	71	75
	Mm		105	107	72	52	81	84	71
15	Mm	260 m W	420	627	125	430	682	470	240
16	Sm	680 m W	40	38	36	29	28	36	29
25	Sm	350 m S	—	—	—	—	—	—	25
	Mm		185	170	200	135	125	210	190
Three Site Mean (5, 10 & 15)			260	254	181	211	291	243	159
Phytotoxicology Upper Limit of Normal in Urban Tree Foliage			175	175	175	175	175	175	175

[1]Not available.

Sm - Silver maple; Mm - Manitoba maple; Nm - Norway maple

APPENDIX I

Derivation and Significance of Ministry 'Upper Limits of Normal' Contaminant Guidelines

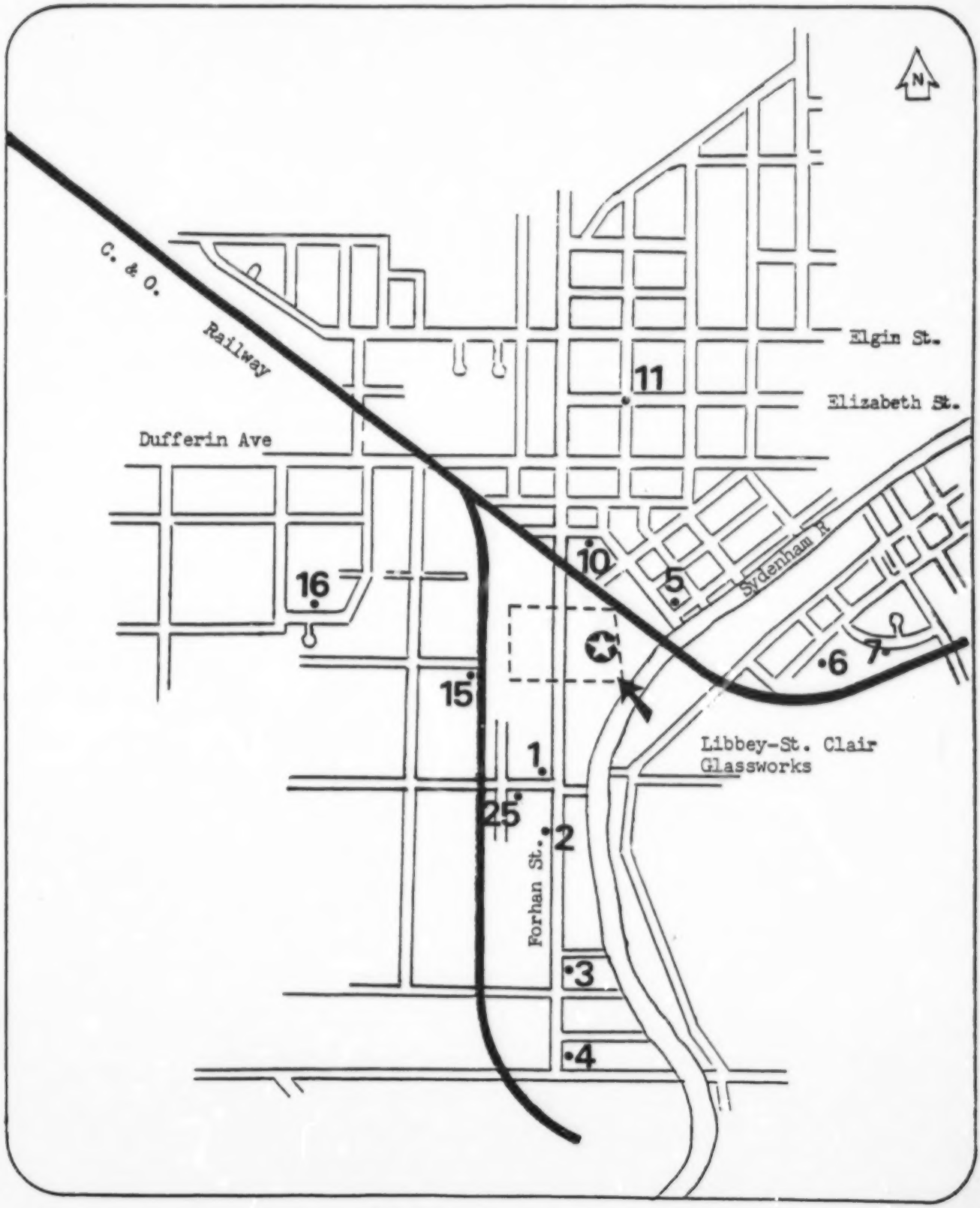
The MOE 'upper limits of normal' contaminant guidelines essentially represent the expected maximum concentration of contaminants in surface soil (non-agricultural), foliage (tree and shrub), grass, moss bags an/or snow from areas of Ontario not subject to the influence of point sources of emissions. 'Urban' guidelines are based upon samples collected from centres of minimum 10,000 population. 'Rural' guidelines are based upon samples collected from non-built-up areas. Samples were collected by MOE personnel using standard sampling techniques (ref: Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch: Technical Support Sections - NE and NW Regions). Chemical analyses were performed by the MOE Laboratory Services Branch.

The guidelines were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. For those distributions that are 'normal', 99% of all contaminant levels in samples from 'background' locations (i.e. not affected by point sources nor agricultural activities) will lie below these upper limits of normal. For those distributions that are non-normal, the calculated upper limits of normal will not actually equal the 99th percentile, but nevertheless they lie with the observed upper range of MOE results for Ontario samples.

Due to the large variability in element concentrations which may be present across Ontario, even in background data, control samples should always be collected. This is particularly important for soils, which may show large regional variations in element composition due to differences in parent material. Species of vegetation which naturally accumulate high levels of an element also may be encountered.

It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of the above normal concentration(s). Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations which are below the guidelines are not known to be toxic.

FIGURE: 1 Phytotoxicology Surveillance Sites in the Vicinity of Libbey-St.Clair, Wallaceburg



Not To Scale

FIGURE: 2 Boron in 1989 Maple Foliage x Distance from Libbey